MOLLUSCA-PERIODS IN THE SEDIMENTS OF THE HUNGARIAN PLEISTOCENE. III. THE UPPER HUMID PERIOD OF THE BORING OF FELSŐSZENTIVÁN

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The second part of the work (Acta Biol. Szeged, 1963. Tom. IX. Fasc. 1—4, p. 101, 115) dealt with the sediments between 1,6—11 m of the boring of Felsőszentiván. This series of sediments was named by the author as the upper arid period and was shortly designated with the Roman numeral I. The period was divided into 8 subperiods (I./1—I./8) on the basis of the fauna. The I. period was characterized by the lack of aquatic fauna, by the sporadic occurrence of thermophilic species and by a more or less arid and cold climate.

Below the sediments of the I. period lies the upper humid period between 11 and 14,5 m. In contrast to the former period the aquatic and thermophilic fauna occurs in all samples of the period, the aquatic fauna is rich, the number of individuals of the thermophilic species is significant, the climate of the period is more humid and milder. The period is designated with II. and was divided into 4 subperiods (II./I.—II./4) on the basis of the fauna. Review of the period follows according to these subperiods.

Subperiod II./1. 11—11,6 m.

The layer is 60 cm thick. It consist of humus and mud containing loess with plant relics. In the three 20 cm thick samples in all 1725 *Mollusca* individuals were found. This subperiod sharply differs from subperiod I./8 through its fauna characteristic to the period II. and from the subperiod II./2 through its relative poor fauna.

The number of **aquatic species** is considerable, 7 from the 29 species of the subperiod. The number of individuals, however, belonging to these 7 species is only 70, hardly the 25th part of the total number of the *Mollusca* individuals. *Valvata pulchella* (22 pieces) is rare today on the Hungarian Plain; in this connection it may be considered as a nordic, oligothermic species. On the basis of its number of individuals it did not attain its optimum not even in this subperiod. But the high number of individuals shows a climate which was colder than that of today. *Anisus spirorbis* (20 pieces) is at present the most frequent aquatic snail of the Hungarian Plain. In the moun-

tains it is much rarer and it occurs in our loesses also rarer than at present. It is an enduring ubiquitous organism. In the relation of Pleistocene, however, it may be considered as an eurythermic thermophilic species. The moderate number of individuals may be attributed to a climate which was colder than that of today. *Anisus leucostoma* (15 pieces). On the Hungarian Plain it may be considered as an oligothermic species because it occurs more frequently in the loess than as recently. *Galba truncatula* (7 pieces). Also this species is more frequent in the loess, it is rather an eurythermic and oligothermic organism. *Anisus planorbis* (3 pieces) and *Valvata cristata* (2 pieces) are eurythermic species, but considering their optimum temperature they are somewhat polythermic. The low number of individuals may be attributed to the cold climate. *Pisidium cinereum* (1 piece) is an enduring ubiquitous organism. At present it is a very frequent species on the Hungarian Plain. The lack of *Bithynia tentaculata, Limnaea stagnalis* and *Radix ovata* — which are much rarer in the Pleistocene — emphasises the Pleistocenous character of the coenosis. Number of individuals of the aquatic species diminishes upwards from below (34, 24 and 12 resp.). The number of species does not show this downward tendency; 6 species from the 7 species of the subperiod occur in the uppermost boring-sample too. The diminishing is not parallel with the sequence in the tolerancy of desiccation; in the uppermost sample the number of the desiccation mostly tolerating *Anisus spirorbis* considerable diminishes and at the same time the bi branchiate aquatic snails of the subperiod occur too. On this basis the water seems a permanent one. The poor fauna may be attributed to the low temperature of the water while the diminishing of the number of individuals may be explained by the increase of cold and aridity and by the fall of the water. Entire and permanent ceasing of the aquatic fauna above the subperiod indicates the drying up of the water and the beginning of the upper arid period.

The 308 individuals of the **amphibic** category are distributed into 2 species. Number of individuals of *Succinea oblonga* (281 pieces) is considerable lower than in the neighbouring periods I./8 and II./2. This may be explained by the low temperature and humidity. *Carychium minimum* (27 pieces) is lacking in the period I. while it occurs continuously in the period II. Its occurrence is simultaneous with the aquatic fauna although in a humid biotop it subsists also far from the water. It is an eurythermic organism. The southern form (subsp. *tridentatum* Risso) is not known from the boring of Felsőszentiván. Recently, however, this subspecies occurs in Middle-Europe too.

In the subperiod the most populous group is that of the **terrestric ubiquitous** organism (11 species and 1093 exemplars). This fauna is similar to the fauna of the lowest subperiod of the upper arid period (I./8). As comparison, behind the quantitative data of the species, author gives also the qualitative data of the 3 lowest samples of the subperiod I./8 drawn together in parentheses. These numbers refer to identical quantity of the samples. *Pupilla muscorum* 306 (333) exemplars. It is more resistant against cold and aridity than the other ones. It is the preponderantly dominant species in both subperiods. The quantitative differences in the number of individuals, taking into consideration the differences between the single samples, are unimportant. It may be supposed that the humidity with low temperature of these subperiod was a little disagreable for it. *Trichia hispida* 118 (258) exemplars. The decrease of quantity is considerable. It is the most frequent snail of the Hungarian Plain. It is resistant against

cold or most correctly it may be considered as a cold-lover, because it rambles even on winter-days. Its demand on humidity is considerable but at low temperature it is satisfied with lower humidity too. the decrease may be due to the effect of cold humidity. *Vertigo pygmaea* 214 (12), *Vallonia costata* 174 (15), *Vallonia pulchella* 91 (14), *Cochlicopa lubrica* 66 (23), *Vallonia enniensis* 54 (3), *Deroceras agreste* 32 (21), *Vitrea crystallina* 17 (6) occur continuously in the subperiod I./8 too, but the number of individuals is there much lower. They are small, against cold and aridity resistant and from before unfavourable conditions easily hiding organism. Increase of number may be due to the rising of humidity and warmth. Rising of temperature is proved by the considerably increased number of individuals of the rather thermophilic *Vallonia enniensis* and of the eurythermic but rather thermophilic *Vallonia costata*. It is to be noted that the sequence of the *Vallonia* species adjusts itself to the cold-resistance and not to the thermophily. Predominance of *Vallonia costata* is due to its highest cold-resistance. The number of indviduals of these species show, however, more or less unfavoŭrable conditions, not because humidity was low, but because warmth was lacking. *Vertigo angustior* (10) does not occur in the upper arid period. It appears first in the subperiod II./1 and from here downwards it occurs continuously. It is sensitive to great coldness. Its appearence shows the increase of temperature but this increase was not a great one which shows the low number of individuals. *Punctum pygmaeum* too occurs from here downwards continously. In the upper arid period only 3 exemplars of this species were found. On the Hungarian Plain it is an oligothermic species. Its appearence and survivance is due mostly to the increase of humidity.

Inhabitants of groves are represented by 6 species and 76 individuals. *Perpolita hammonis* (55 exemplars) occurs continuously both upwards and downwards. Number of individuals upwards diminishes and downwards increases. The increase indicate the rise of humidity, vegetation and temperature. In Hungary it is an inhabitant of mountains, and on the Hungarian Plain it may be considered as an oligothermic species. It lives permanently next to waters, the low number of individuals is caused therefore not by the lack of water but by the low temperature. This show a climate which was much colder than at present. *Fruticicola fruticum* (13 exemplars). In the upper arid period it was not found, in this period it occurs downwards continually from the beginning. This snail is considerably large and therefore the low number of individuals found in the small boring-samples does not prove its rarity. Its constant occurence show rather a frequent occurence. It is an important element of the *Mollusca* fauna of North-Europe. It shows a preference for groves. *Arianta arbustorum* (2 exemplars). In the boring of Felsőszentiván it occurs first in the upper sample of this subperiod. Three samples deeper from the beginning of the subperiod II./2 it occurs downwards continually. Its distribution and its requirements are similar to them of the former species. The occurence of both species proves the increase of humidity and vegetation. They prefer first of all the groves with deciduous trees and their occurrence makes probably the presence of such vegetation. Besides they occur in pine-woods and above the timber line in low vegetation too. On the Hungarian Plain they are oligothermic species and they indicate a climate which was colder than at present. *Goniodiscus ruderatus* (2 exemplars). In the profil this

species too appears first in the upper sample of the subperiod II./1. In the other two samples of the subperiod it is lacking, while from the subperiod II./2 downwards it occurs continually. In Hungary it is a sporadic and oligothermic inhabitant of mountains. It is a frequent species in North-Norway. Its occurrence in the subperiod proves a much colder climate than at present and it makes probably the occurrence of groves. *Perforatella bidens* (1 exemplar). In the profil it appears with the two former species and its further occurrence is also similar. It is sensitive to great coldnes but here it proves a climate colder than that of today. Its occurrence indicates much humidity and the presence of deciduous groves, although it occurs in low vegetation too. *Pupilla sterri* (3 exemplars). It occurs only in the upper sample as the last case of its continuous occurrence in the upper arid period. It prefers the moderately cold and arid climate, its disappearence is comprehensible in the cold and humid climate. At present it is an inhabitant of rocks in the mountains. Its occurrence undoubtedly proves a climate which was colder than the present one.

Three species and 178 individuals of the **thermophilic organisms** were found. *Imparietula tridens* (115 exemplars). Its continuous occurrence begins already in the subperiod I./8. But there were found only 18 exemplars in the 5 samples. The number of individuals considerably increases in the subperiod II./1, its occurrence continues in the subperiod II./2 with a smaller number of individuals. The inconsiderable increase of number is due to the warmth and not to humidity. It indicates a climate which was much warmer than of the subperiod I./8. Besides it occurs also on humid places if they have a sufficiently warm microclimate. It is therefore understandable that in the subperiod this is the dominant thermophilic species. *Abida frumentum* (61 exemplars). In the profil it appears first in the upper part of the subperiod II./1 and downwards it occurs continually beyond the subperiod too. Its requirement for warmth is greater than that of the former species. It avoids the humid places in consequence of their cold microclimate. It indicates a considerable warmth but it does not preclude a climate which was colder than at present. *Helicella hungarica* (2 exemplars). It occurs here only in the upper sample. In the lower part of the subperiod I./8 it occurs continuously, although only in small numbers. Below the subperiod II./1 it occurs also discontinuously. Its requirement for warmth is higher than that of the former species, it avoids more humid places. The number of individuals here is due to humidity.

The **oligothermic** *Vallonia tenuilabris,* which occurs at present only in Asia, is here lacking, although it occured continuously in the subperiod I./8. This disappearence indicates rise in temperature.

On the basis of the foregoing the following **reconstruction of the circumstances** may be given. The climate of the subperiod was much warmer and more humid than that of the subperiod I./8, and considerable colder and arider than the present climate of the Hungarian Plain. On the area there was a cold standing water which gradually diminished due to the insufficient quantity of rainfall. Its desiccation was delayed through low temperature. The vegetation was steppe-like with groves on the shores. In the groves occured possibly cold-resistant deciduous trees (probably *Betula, Alnus, Salix* etc.) besides pines.

Subperiod II./2. 11,6—12,4 m.

This layer is 80 cm thick. It consists of humus and mud containing loess and includes plant residues. The lowest sample (12,2—12,4) consists of running sand. The subperiod may be clearly distinguished from subperiod II./1 through a richer and from subperiod II./3 through a poorer fauna. In the subperiod altogether 10 584 exemplares were found. Number of species was 42 (in the subperiod II./1 only 29!). The **aquatic fauna** is represented by 18 species and 954 individuals. The species of the subperiod II./1 occur also here but the number of individuals are much higher. In low numbers occur further 11 species. The great majority of individuals (601) belong to such 7 species which are on the Hungarian Plain more frequent in loess as recently and therefore they may be considered as oligothermic organism. These species are as follows: *Anisus leucostoma* (408 exemplars), *Galba truncatula* (117 exemplars), *Valvata pulchellla* (40 exemplars), *Gyraulus laevis* (18 exemplars), *Pisidium obtusale* (9 exemplars), *Aplexa hypnorum* (5 exemplars), and *Bithynia leachi* (4 exemplars). A climate which was colder than at present is proved by the dominance of *Anisus leucostoma* and by the high number of *Valvata pulchella.* The Pleistocene character of the fauna is underlined also by the continuous occurrence of *Gyraulus laevis* which has a holarctic distribution but is generally infrequent at present.

The other individuals represent mostly eurythermic species which are frequent recently and in the loess as well. In Hungary they occur rather on the plains than in the mountains. They may be considered here as a slightly polythermic organisms. These species are the followings: *Anisus spirorbis* (3198 exemplars), *Anisus planorbis* (56), *Valvata cristata* (33), *Planorbis corneus* juv. (5), *Anisus vortex* (1); altogether 5 species and 293 individuals. Number of individuals was diminished probably by a climate colder than at present.

The eurythermic and ubiquitous *Pisidium cinereum* (46 exemplars) proves only the presence of water.

The polythermic aquatic fauna (which may be considered as such in the Hungarian Pleistocene) is represented by 5 species but only by 14 individuals. *Anisus septemgyratus* (9 exemplars) is in the loess locally frequent, but at present it occurs northwards only as far as Germany and Middle-Russia. Its presence therefore excludes a very cold climate. *Physa fontinalis* (2 exemplars), *Bithynia tentaculata* (1) and *Segmentina nitida* are in Hungary more the inhabitants of the plains than that of the mountains. In the loess they are rarer than recently. Their occurrence and especially their joint occurrence proves a climate which was milder than that of the subperiod II./1. Their low number proves a colder climate than at present. *Anisus carinatus* (1 exemplare) is in Hungary equally rare, recently and int the loess as well. Its distribution shows a preference for oceanic climate, which is in comparison with the climate of the Pleistocene mild and humid and in comparison with the present climate of the Hungarian Plain cool and humid.

The aquatic fauna of the subperiod is the richest in the third sample from above (12,0—12,2 m). Upwards it diminishes fast and steadily. This proves that the water gradually diminished because the rainfall could not entirely substitute for the loss of water through evaporation. The considerably evaporation indicates a climate with relatively warm summers. In the Holocenous

climate several standing waters came into existence on the Hungarian Plain; the climate of the subperiod was therefore arider.

The **amphibic fauna** is represented by *Succinea oblonga* (2803 exemplars) and *Carychium minimum* (600), altogether 3403 individuals. They occur from the subperiod II./1 continuously. The high increase of the number of individuals is due to the increase of temperature and humidity. In the upper three samples the gradual decrease of the aquatic fauna is shown also by the amphibic organism. The immediate cause of the decrease of number of individuals is here not the decrease of the water itself but the decrease of the humidity of the shores. This latter, however, may be explained similarly as the decrease of the water.

The **hygrophilic terrestric ubiquitous** organisms are represented by 13 species and 5 777 individuals. The species, which occured already in the subperiod II./1, occur here generally in higher number; increase of temperature and humidity was favourable for all species. The changes of the environmental factors were, however, differently advantageous for the different species. The sequence of the species is therefore an other than in the subperiod II./1. *Vallonia pulchella* (1 525 exemplars) forges ahead from the fifth place. *Pupilla muscorum* (1 125 individuals) is here the second. In the subperiod II./1 it was the first. A greater number would be found if the area were a little arider. *Vertigo pygmaea* (1112 exemplars). Its conditions of living became more advantageous. It follows also here *Pupilla muscorum. Vallonia enniensis* (757 exemplars). It is here the forth; in the subperiod II./1 it was the seventh. It is a rather thermophilic organism. Increase of number indicates a considerable increase of temperature. *Vallonia costata* (307 exemplars). In the subperiod II./1 it was the fourth, here it is the fifth. Increase of its number in the two upper samples is rather considerable. In the two lower samples its quantity is similar to that of the subperiod II./1. A greater degree of multiplication was hindered by the temperature which was lower than its optimum. *Trichia hispida* (299 exemplars). Before, it was the fourth. Here, it is the sixth. Increase of numbers indicates more favourable conditions. This increase may be attributed to the rise of temperature of the humide water-shores. Increase of number of *Cochlicopa lubrica* (264 exemplars) may be explained by the same cause. Increase of number of individuals of the relatively thermophilic *Vertigo angustior* (152 exemplars) proves the increase of temperature. The conditions for livings of *Deroceras agreste* (126 exemplars) became considerable more favourable while them of *Punctum pygmaeum* (44 exemplars) and *Vitrea crystallina* (27 exemplars) did not change very much. These two latter species are on the Hungarian Plain at present oligothermic species. *Euconulus trochiformis* (22 exemplars) occurs continuously but only in low number. It did not occur in the subperiod II./1. It is resistant to cold but at the same time it requires humidity. Its presence here proves the increase of humidity. *Vertigo antivertigo* (17 exemplars) appears first here in the boring. It requires more warmth and humidity than *Vertigo pygmaea.* Its quantity is therefore insignificant as compared to the other species. Its presence indicates a temperate cold and more humidity.

Similar ubiquitous populations are found at present in the lower parts of our mountains on shores in the rich vegetation and in the plant debris. The population proves much humidity and a great degree of covering by plants.

It excludes a very cold climate and makes probably a climate which is colder than that of the Hungarian Plain at present. This climate was, with all probability, moderately cold.

Six species and 237 individuals of the **inhabitants of groves** were found. Number of species is the same as in the subperiod II./1. 5 species of the six occur in both subperiods. Dominant is also here *Perpolita hammonis*. Number of individuals is here increased. Increase of number of *Perforatella bidens* (53 exemplars) is the highest. This species is oligothermic in a lower degree than the former one. Its occurrence indicates a considerable increase of temperature. *Arianta arbustorum* (28 exemplars) occurs here in greater number. This is a little oligothermic species. *Fruticicola fruticum* with a similar requirement is represented by 17 individuals only. Number of the considerable oligothermic *Goniodiscus ruderatus* (11 exemplars) is also increased, its occurrence became continuous but the number of individuals remains low. *Clausilia dubia* (1 exempl.) appears only here in the whole upper humid period. In Hungary it is at present an inhabitant of the mountains and in the boring indicates a climate which was colder that at present. *Pupilla sterri* (1 exemplar) occurs only in the uppermost sample of the subperiod II./1. It may be supposed that it is lacking here because of the cool humidity.

The grove-inhabitant population described above proves a climate which was colder, than that of today and it proves also a great covering degree of the vegetation. Some of the species occur on places with open vegetation too but the occurrence of the whole population in open vegetation is improbable. Presence of groves is made probable by the rather rich ubiquitous fauna and by the continuous presence of water too. Pinewood is not liked by snails because of the unfavourable mechanical properties of the fallen pine-needles. Author found rather rich populations along the torrents of the Alpes in *Piceetea* but the population of the subperiod fits better into deciduous groves than into pine-woods. On the basis of the climate reconstructed with the aid of the fauna and on the basis of his personal experiences author thinks that the vegetation of this subperiod was similar to that of the subperiod II./1, i. e. it was a vegetation from cold-resistant deciduous trees.

The **thermophilic organisms** are represented by 3 species and 213 individuals. Comparing with the subperiod II./1 the value of the "thermophilic species altogether" shows a considerable rise in the second sample, while in the upper sample a little, in the lower one a very considerable diminishing may be observed. From the 3 species *Abida frumentum* (129 exemplars) is the first. This species has an intermediate position from the point of view of thermophily. Its great quantity in the second sample (11,8—12,0 m) is very remarkable and indicates that this sample was the warmst point of the whole period. In the upper sample it occurs in a much lesser quantity, although this is yet more than the quantity in the subperiod II./1. In the two lower samples the quantity is considerable smaller than in the subperiod II./1. *Imparietula tridens* (76 exemplars) occurs in relatively great number, but this quantity is in the two upper samples a little, in the two lower samples considerable smaller than in the subperiod II./1. The most thermophilic *Helicella hungarica* (8 exemplars) proves in the two upper samples a warmth higher than that of the subperiod II./1. In the two lower samples it lacks almost entirely. A climate which was warmer than that of the subperiod II./1. is proved therefore by the thermophilic fauna of the

two upper samples too. In the two lower samples, on the basis of the thermophilic fauna, the contrary might be concluded. From the analysis of the other parts of the fauna, however, is clear, that the climate was also here warmer. The smaller number of the thermophilic organisms is due here to the humidity.

On the basis of the analysis of the fauna **the climate of the subperiod II./2** was milder and more humid and colder and more arid than the climate present. Generally this climate was moderately cold and rather humid. The cold is caused by the cooling effect of the moderately thick inland ice-cover in Scandinavia. On the area there was a standing water which, in consequence of the arid and relatively warm summers, gradually diminished. On the shores there were cold-resistant deciduous groves. From the point of view of natural surroundings the subperiod was inhomogeneous. In the lowest sample the fauna is the fifth of that of the uppermost sample of the subperiod II./3. This change indicates the beginning of an arid and continental climate. The summers were mildered in consequence of the inland ice-cover and the colder winters were unfavourable for the fauna. The following sample shows the increase of humidity and warmth. The increase of temperature was caused by the foregoing of the evolution of the climate-type and the diminishing of the ice-cover. The increase of humidity originated rather from the melting of ice than from the rainfall. The fauna of the subperiod is here the richest. In the following sample the aquatic fauna considerably diminishes and diminishes also the terrestric fauna. The thermophils, however, have here a peak. The warm and arid climate-type here is the most expressed. In the upper sample the aridity increases and at the same time the temperature diminishes.

Subperiod II./3. 12,4—14,0 m.

This layer is 160 cm thick. It consists of running sand. Two samples of 20 cm and four samples of 30 cm belong to this subperiod. Its rich fauna clearly distinguishes it from the subperiods above and below. Number of species is 50, number of individuals 51 379.

The **aquatic fauna** is represented by 25 species and 11 999 individuals. The three groups, which was distinguished in the case of the subperiod II./2 are found also here. The group of the slightly polythermic organisms is here the first and not the second. Number of species belonging to this group is 8, that of the individuals 7567. Their distribution is the following: *Anisus spirorbis* 6405, *Anisus planorbis* 576, *Valvata cristata* 484, *Stagnicola palustris* 43, *Planorbis corneus* 29, *Gyraulus crista* 22, *Valvata piscinalis* 7, *Gyraulus albus* 1. Dominant is *Anisus spirorbis;* the number of individuals belonging to this species is more than the half of the number of all aquatic organisms. The sequence of the species which occur in this subperiod and in the subperiod II./2 as well is the same in both subperiods, the number of individuals, however, is much higher. *Stagnicola palustris,* which was lacking in the subperiod II./2, has here the fourth place; therefore *Planorbis corneus* has here the fifth place. *Gyraulus crista, Valvata piscinalis* and *Gyraulus albus* appear in the period first here, but only in low number. *Anisus vortex* was not found here; in the subperiod II./2 was found only 1 exemplar.

The oligothermic group is represented by 11 species and 3 850 individuals. Their sequence is as follows: *Galba truncatula* 2060; *Valvata pulchella* 862,

Anisus leucostoma 616, *Aplexa hypnorum* 92, *Gyraulus laevis* 91, *Bithynia leachi* 88, *Pisidium obtusale* 22, *Pisidium personatum* 14, *Bathyomphalus contortus* 3, *Pisidium pulchellum* 1, *Pisidium nitidum* 1. This group has here the second place, but it has a significant role. In the quantitative sequence of the aquatic organisms the second, third and fourth place take the members of this group *(Galba truncatula, Valvata pulchella, Anisus leucostoma).* It indicates an increase of temperature that the only slightly oligothermic *Galba truncatula* predominates, while the considerably oligothermic *Anisus leucostoma* loosing its first place became the third. Increase of number of *Valvata pulchella* and the locale increase of number of individuals of oligothermic organisms, especially in the upper part of the period, prove a cold climate after all. The species of the oligothermic group found in the subperiod II./2 occur also in this subperiod. *Bathyomphalus contortus, Pisidium personatum, Pisidium pulchellum* and *Pisidium nitidum* appear first here in the period, but only in insignificant numbers and in the sequence they have the four last places. *Pisidium pulchellum* and *Pisidium nitidum* are in Hungary rare, recently and in the Pleistocene as well.

Increase of number of individuals of the eurythermic *Pisidium cinereum* (553 individuals) is very considerable.

The polythermic aquatic fauna is represented by 5 species and only 29 individuals. The continuous occurrence of *Anisus septemgyratus* excludes a great coldness, the low number of individuals shows a climate which was colder than at present. Increase of number of *Segmentina nitida* (9 exemplars) shows perhaps a slight increase of temperature. *Anisus carinatus* (5 exemplars) occurs only in the uppermost and lowest samples. *Viviparus viviparus* (2 exemplars) appears only in those two samples where the considerable increase of the aquatic fauna indicates an increase of the water too. *Valvata piscinalis* (see in the group of the slightly polythermic organisms) was found in the same two samples. This organism prefers the clear water. *Physa fontinalis* (1 exemplar) was insignificant as well as in the former subperiod. *Bithynia tentaculata* was not found; in the subperiod II./2 was found only one individual.

In this subperiod the aquatic fauna found more favourable conditions than in the subperiod II./2. The increase of the number of slightly polythermic organisms against the oligothermic ones and the dominancy of the slightly oligothermic *Galba truncatula* among the oligothermic organisms indicate the rise of temperature. Change of climate, however, was favourable for the oligothermic organisms too, though only in a smaller degree. This is proved by the locally considerable increase of number of individuals. The climatic change did not influence the polythermic organisms. Their role is insignificant as in the subperiod II./2. The value of the „aquatic species altogether" shows a considerable rising tendency. A relapse may be observed only in the third sample (from below) and in the uppermost sample. This latter is, however, in the neighbourhood of the subperiod II./2 and the relapse is therefore naturally. According to all these, the quantity of water was increased by the rainy climate and by the melting of ice. This excludes the presence of arid and warm summers and proves an oceanic climate with mild winters. The aquatic fauna observed fits into this moderately cold climate with mild winters.

The category of **amphibic organisms** is represented also here by *Succinea oblonga* (14447 exemplars) and *Carychium minimum* (1141 exemplars). This great increase proves the increase of the humidity with favourable temperature

of the shores and its fluctuations as well as the aquatic fauna proves that of the waters. *Succinea oblonga* is already rare above the 60 degree of latitude. Where it occurs in such a great quantity, the climate could not be a very cold one.

The fauna of the **hygrophilic ubiquitous organisms** is similar to that of the subperiod II./2. The same 13 species were found here too. The number of individuals increased considerably, it was 19956 in all. *Vertigo antivertigo* occurred only in the two lowest samples of the subperiod II./2; here it occurs continuously and the number of individuals too is rather high. The other species occur also continuously, as in the subperiod II./2; only *Vitrea crystallina* is lacking in two samples. The quantitative sequence of the species is the following: *Vallonia enniensis* (6254 exemplars). It gets the first place (before it was the fourth), although it dominates only in two samples. The great increase in number indicates humid and mild surroundings. *Vertigo pygmaea* (5706 exemplars). The same favourable effects promoted it from the third place to the second one. It dominates in the three lower and in the uppermost samples, where the colder climate was more favourable for it than for the more thermophilic *Vallonia enniensis*. *Vallonia pulchella* (3140 exemplars) is forced to the third place from the first one, although the conditions of living remain favourable for it. It is not a dominant in the samples but in the two lower samples it precedes the more thermophilic *Vallonia enniensis*. *Pupilla muscorum* (861 exemplars) has here the fourth place instead of the second one. Conditions of living were most favourable in the subperiod II./2 because of the more warmth in summer. *Euconulus trochiformis* (782 exemplars) is a good cold resistant organism but it is hygrophilic too. The number of individuals is considerably increased. Cold-resistance and requirement of humidity of *Cochlicopa lubrica* (755 exempl.) and *Deroceras agreste* (654 exemplars) is considerable. Number of individuals of these two latter species is increased in the three upper samples, downwards this number is slightly, and in the lowest sample considerably diminished. *Vertigo angustior* (554 exemplars). In the Pleistocene it was a thermophilic species. The conditions of life were in three of the six samples umchanged, while in the other three samples these conditions became considerable favourable in consequence of mild humidity. *Trichia hispida* (478 exemplars). Increase of its quantity in the uppermost sample is very considerable. It may be found in great quantity recently in the mountains, on lower places, next to water in humid surroundings. In the uppermost sample the microclimate was similar. In the following too samples the number of individuals is similar to that observed in the subperiod II./2, while in the three lower samples the number considerably diminishes. For this species it would be perhaps favourable more warmth in the humid second sample while more aridity in the colder climate of the lower samples. The mild humidity was favourable for *Vertigo antivertigo* (446 exemplars). For the more thermophilic *Vallonia costata* (276 exemplars) were the warmer summers of the subperiod II./2 more favourable than the mild winters of this subperiod. The conditions of life for *Punctum pygmaeum* (38 exemplars) and *Vitrea crystallina* (12 exemplars) changed only slightly. After all, this group indicates a similar climate in the terrestric biotops as the aquatic fauna in the water. On the basis of the snail-population a high covering degree of the vegetation may be supposed.

Number of species of the **inhabitants of groves** is 6, similarly to the subperiod II./2; number of individuals is 663. *Perpolita hammonis* (408 exemplars)

is also here dominant. Its quantity increases considerably in the two upper samples. In the two following samples its quantity is about the same as in the subperiod II./2. In the two lower samples its quantity is considerably diminished. The conditions for *Arianta arbustorum* (106 exemplars) became more favourable. *Pupilla sterri* (64 exemplars) indicates a climate which was colder than that of today. This organism is lacking in the subperiod II./2. The conditions for *Perforatella bidens* (52 exemplars), *Fruticicola fruticum* (18 exemplars) and *Goniodiscus ruderatus* (15 exemplars) did not change essentially. *Clausilia dubia* is lacking; in the subperiod II./2 was found only 1 exemplar. As compared with the subperiod II./2 the conditions for the fauna were in four samples more favourable while in two samples less favourable. The advantages of the mild and humid climate are shown therefore on the inhabitants of groves too.

The 3 **thermophilic species** occurring in the subperiod II./2 are found also here. Number of individuals is 160 in all. In contrast to the former subperiod here *Imparietula tridens* (124 exemplars) is the dominant. This species may be found mostly on more humid places. The condition for it were in the two upper samples more favourable than in the former subperiod. In the three lower samples the conditions were more disadvantageous than in the former subperiod, possibly in consequence of the cold and humid surroundings. *Abida frumentum* (26 exemplars), which prefers arider places in consequence of its thermophily, has in the two upper humid samples only a small role, in the lower samples it just occurs. The most thermophilic *Helicella hungarica* (10 exemplars) is here so subordinant as in the subperiod II./2. The differences between the subperiods II./2 and II./3 are caused by the cooler and more rainy climate of the latter.

In the uppermost sample the **oligothermic** *Vallonia tenuilabris* (3 exemplars) indicates a colder climate than that of today but at the same time the low number of individuals shows, that the cold was not a very strong one.

On the basis of the data above **the climate of the subperiod** II./3 was of a more oceanic type, more humid, with cooler summers and milder winters than the climate of the subperiod II./2. This climate was colder than that of today, after all it was moderately cold which was caused probably by the cooling effect of the inland ice-cover in Scandinavia. On the area there was standing water. The quantity of this water was twice considerable increased by rainfall and by melting of ice. On the shores there was a rich vegetation, possibly from cold-resistant deciduous trees. In the lowest sample the change of climate is indicated by the general and considerable increase of the fauna. In the following sample the fauna increases in consequence of increase of humidity. According to authors supposition, increase of humidity was caused in first line by the melting of ice in consequence of the mildering of climate and not by rainfalls. In the following sample the fauna became poorer in consequence of the decrease of humidity. This decrease is caused probably by the slowing of the melting process. In the two following samples the humidity and the temperature considerably increase. The causes of these changes were probably the gradual evolution of the climate-type and also the decrease of the inland ice-cover in Scandinavia. In the upper sample the considerable diminishing of the fauna is caused by the neighbouring climate-type. But the fauna is yet rich enough for a clear distinction from the subperiod II./2. These changes are unambiguosly indicated by the categories of the aquatic, amphibic, hygrophilic terrestric ubiquitous and groves inhabitant organisms.

Subperiod II./4. 14,0—14,5 m.

This layer is 50 cm thick. It consists of running sand. A sample of 30 cm and an other of 20 cm were investigated. Number of species is 27, that of the individuals 601. The subperiod may be clearly distinguished by the fauna which is upwards much richer and downwards much poorer. The data „*Mollusca* exemplars altogether" of the middle arid period bordering downwards this subperiod are the followings: 33, 38, 15, 54, 39 etc. In the subperiod II./4 the **aquatic fauna** is represented by 10 species and 126 individuals only. Disregarding from the considerable impoverishment, the fauna is similar to that of the subperiod II./3. Here is the slightly polythermic eurythermic group the dominant one. It is stricking the superiority of *Anisus spirorbis* (77 exemplars). The number of individuals of the other species is small: *Valvata cristata* 7, *Anisus planorbis* 6, *Stagnicola palustris* 3, *Planorbis cornea* 1. Three species, which occurs in the subperiod II./3 in the lowest numbers, here are lacking.

From the oligothermic group (4 species and 23 individuals) occurs also here *Galba truncatula* in the highest number (15), and follows also here after *Anisus spirorbis*. The number of individuals of the other species is small: *Valvata pulchella* 4, *Gyraulus laevis* 2, *Pisidium obtusale* 2. Number of the species decreased with 7, but from these occured 4 in the subperiod II./3 only in small number.

The polythermic group is lacking. But its quantity was also in the subperiod II./3 insignificant. From these changes a more arid and colder climate may be supposed.

The category of **amphibic organisms** is represented by 133 *Succinea oblonga* and by 59 *Carychium minimum*, in all by 192 individuals. All two species occurs continuously from above. The considerable decrease of their number is due to the arider and colder climate.

The **hygrophilic ubiquitous organisms** are represented by 12 species and 271 individuals. *Vitrea crystallina* did not appear, it occured however, in the subperiod II./3 in the lowest number too. The other species are common with the subperiod II./3, its quantity, however, is much reduced. The sequence is the following: *Vertigo pygmaea* 79, *Vallonia pulchella* 69, *Vallonia enniensis* 56, *Cochlicopa lubrica* 16, *Vertigo angustior* 11, *Pupilla muscorum* 9, *Deroceras agreste* 8, *Trichia hispida* 8, *Vertigo antivertigo* 6, *Euconulus trochiformis* 5, *Vallonia costata* 3, *Punctum pygmaeum* 1 exemplars. The dominant species are also here the same which were the dominants in the subperiod II./3. The quantity of the other species is also here much smaller. *Vallonia enniensis* gets here the third place instead of the first. This indicates the decrease of temperature, the high number of individuals, however, shows only a temperate cold. On the first place *Vertigo pygmaea* is found. This is not very stricking, because it was in three samples of the subperiod II./3 the dominant species. The dominancy of this species too indicates the temperateness of the cold. The more cold-resistant *Vallonia pulchella* precedes *Vallonia enniensis*. The fauna, after all, is similar to that of the subperiod II./3. It indicates, however, an arider and colder climate and the decrease of vegetation.

From the group of the **inhabitants of groves** only *Arianta arbustorum* (4 exemplars) and *Perpolita hammonis* (3 exemplars) were found. The cause of this considerable reduction was probably the decrease of humidity and vege-

tation. Decrease of temperature is indicated mostly by the disappearence of *Perforatella bidens.*

The decrease of the quantity of the **thermophilic organisms** was also considerable. Only *Imparietula tridens* was found, but only in small quantity (5 exemplars). The two other more thermophilic species are lacking. This indicates a considerably decrease of the temperature.

On the basis of the above data **the climate of this subperiod** was much arider and colder than that of the subperiod II./3. The climate was, however, in the Pleistocene only moderately cold. The vegetation get a steppe-like character. The presence of thickets on the shores, however, may not be excluded. The inland ice-cover in Scandinavia was thicker.

The upper humid period and the chronology of the Pleistocene

Author makes an attempt at the placing of the upper humid period into the stratigraphical and into the astronomical chronology. At the beginning, he investigates the two chronology separately from the point of view of the *Mollusca* fauna.

1. The stratigraphical chronology. The boring of Felsőszentiván was conducted by Prof. MIHÁLTZ, a stratigraphical profil and the stratigraphical chronology was completed by him. The stratigraphical data in authors's series of articles were taken from him. Author's task in this chapter is a control of MIHÁLTZ's stratigraphical chronology on the basis of faunaanalysis. Considering the three loess layer of the upper arid period from above as Würm 3, Würm 2 and Würm 1 and the separating running sand layers as the corresponding interstadial periods, the upper humid *Mollusca*-period is indentical with the Riss-Würm interglacial period. The fauna which was much richer than that of the upper arid period and the much milder and humider climate reconstructed on the basis of the fauna prove the interglacial time. On the intervalle of the *Mollusca*-period stratigraphically two parts may be distinguished: till 12,2 m it consists of humus-containing loess and below running sand. This running sand continues below the border of the *Mollusca*-period till 18,6 m. The aquatic fauna occurs in it continuously although only in small number (subperiod III./1) while further down in the loess (subperiod III./2) the aquatic organisms are lacking. Accordingly, the stratigraphical prolongation of the interglacial period downwards with the running sand is proved by the fauna too. The detailed analysis of the middle arid (III.) *Mollusca*-period, however, is the task of the following part of this series of publication.

According to MIHÁLTZ the running sand was transported by westerly winds from the bed of the Danube to this area. For the time of the origin of this running sand he supposes a climate which was milder and humider than that of the period of the origin of the loess but colder than the present climate. This means, that the inland ice-cover was sufficiently thin for permitting the activity of the westerly winds but at the same time this ice-cover hindered the development of climate as mild as that of today. The lower border of the upper humid *Mollusca*-period is not indicated by the sediments, the running sand pass through the subperiods II./4 and II./3 and ends with the lowest sample of the subperiod II./1. The border of the fauna at the end of the subperiod II./3 cor-

responds to the change of the climate-type, while the border of the running sand 20 cm above corresponds to the cease of the westerly winds. Above the border of the running sand the dominantly easterly winds are proved also by the formation of the loess. The direction of the winds was changed appearently by the thickening of the inland ice-cover. The process of the thickening of the inland ice-cover was the result of the climate-changes at the border of the subperiods II./3 and II./2 and it took place in the time when the lowest sample of the subperiod II./2 was formed (i. e. in the time of the formation of the uppermost sample of running sand.) The fauna of this sample is rich after all, but it is considerably poorer than the fauna of the neighbouring samples (especially in the sample below). The poor fauna too proves the worsening of the climate resulting from the thickening of the inland ice-cover. In the stratigraphically homogenous running sand the analysis of the fauna demonstrated four different climates and all of these climates were colder than that of today. The constant presence of the aquatic fauna in the running sand indicates the dominancy of the humidity transporting by westerly winds.

The humŭs containing loess was found between 12,2 and 10,8 m. Subperiods II./2 (except its lowest sample), II./1 and the lowest sample of the subperiod I./8 belong to here. The loess indicates a cold and arid continental climate and the dominancy of easterly winds while the presence of humus indicates a rich vegetation and a mild and humid climate necessary for the developing of such a rich vegetation. From these two follows a relatively mild period of loess formation whith a cold resistant vegetation: steppe with groves. All these corresponds the natural condition which were turned out from the detailed analysis of the fauna. The subperiod II./2 had a milder and humider, while subperiod II./1 had an arider, colder and more tundra-like character. On the basis of its fauna, among others on the basis of the lacking aquatic fauna, the lowest sample of the subperiod I./8 was placed already into the upper arid *Mollusca*-period. According to author's opinion the humus was formed here mostly from the vegetation in the milder and humider climate.

After all, MIHÁLTZ's conception on the process of sediment formation is in all confirmed by the fauna and the fauna corresponds also to the chronological denomination of the sediments. The analysis of the fauna brought new knowledges in the microstratigraphy and made possible a further division of the sediments too.

2. The astronomical chronology. In this chapter author compares the results obtained from the analysis of the fauna with the climate-curve of MILANKOVICH and BACSÁK, as in the case of the upper arid period. In the upper arid period the following of the climate-curve was only possible with the assumption that the Würm 2 and Würm 3 formed an united glacial period (kryon). The lower border of the kryon is indicated by the increase of the fauna, the permanent appearence of the aquatic fauna and the appearence of the first humus-containing zone. If so, the upper humid period is the sediment of the Würm 1 Würm 2 interstadial period and not that of the Riss — Würm interglacial period. The interglacial period Würm 1 is the sediment of the first loess (subperiod III./2) of the middle arid *Mollusca*-period. Advancing upwards on the climate-curve follow the climate changes described below.

Subarctic climate type. It was a duration of 10 400 years. In the profil corresponds to this period the part of the running sand layer located below

the upper humid period already mentioned above. In the fauna the subperiod II./1 corresponds to this climate-type. The average summers of this climate-type were only slightly effective against the chilling effect of the inland ice-cover. They melted, however, this ice-cover in such a degree that the westerly winds could deposit running sand. The cold winters of the climate type together with the chilling effect of the inland ice-cover were very unfavourable for the fauna. The very poor but constant occurring aquatic fauna indicates a tundra-like humidity as against the arid loess of the Würm 1 glacial period. The also very poor terrestric fauna corresponds not no the upper humid period but the middle arid period.

Antiglacial climate-type. It lasted 500 years; in the fauna the subperiod II./4. The warm summers of this climate-type limited the chilling effect of the inland ice and accelerated its melting. The winters too became milder, they were only average winters and the inland ice became thinner too. The vegetation became richer, it was a steppe-like one. The vegetation and fauna were favourably influenced by the presence the mostly from the melting-water feeded standing water. These favourable changes are shown from the considerable increase of the fauna. The short duration of the period corresponds to the short duration of the antiglacial period.

Subtropic (oceanic) climate-type. Its duration was 11 500 years; in the fauna the subperiod II./3. On the climate-curve from the four succeeding periods this was the most favourable from the point of view of the fauna with its averagely mild winters. Correspondingly, the fauna increased very considerably, it is here the richest. BACSÁK supposes a considerable diminishing of the inland ice-cover and a strenghtening of the vegetation. The rich fauna argues in the favour of the diminishing of the inland ice. A climate which was colder than that of today proves on every side the analysis of the fauna, and at the same time disproves the entire disappearence of the inland ice. The lower, relatively poor samples of the subperiod may indicate a thicker inland ice, the much richer upper samples a thinner inland ice. The formation of the sediment indicates no formation of forests, the formation of running sand continued further. The analysis of the fauna, however, indicated a formation of forests. The vegetation and the fauna were also here favourably influenced by the presence of standing water. The presence of standing water and its occasionally considerable increase is an other prove of the relatively mild oceanic climate-type.

Antiglacial climate type. It lasted 7 500 years; in the fauna the subperiod II./2 corresponds to it. From the point of view of the fauna this climate type with its warm summers and normal winters was more unfavourable, its beginning is proved already by the considerable decrease of the fauna. On the lower part of the subperiod the continental character was more expressed, the inland ice-cover chilled here the summers. According to BACSÁK the inland ice-cover became not so thick as thick it was yet in the time of the antiglacial period of 500 years. Accordingly, the fauna is here much richer than in the subperiod II./4. Further on, the gradual decrease of the aquatic and hygrophilic fauna and the considerable increase of the thermophilic fauna are the evidence of an after all warm and arid climate. Increase of the number of thermophilic organisms proves the vigourous melting of the inland ice. According to BACSÁK the inland ice entirely disapperaed to the end of the

antiglacial period. On the basis of the climate of the climatecurve the presence of a cold-steppe vegetation may be supposed. To this corresponds the formation of loess too. A vegetation, which was poorer than that of the former climate-type is proved by the fauna too, but on the basis of the fauna a steppe with groves may be supposed. Presence of groves is the probable consequence of the presence of standing water too. The appearence of humus on the stratigraphical profil may be attributed to the relatively rich littoral vegetation too.

Subarctics climate-type. Its duration is 3 000 years; in the fauna the subperiod II./1. The arid, continental climate, which is unfavourable for the fauna, here continued. The warm irradiation of the summers considerably decreased. The long and cold winters produced tundra-like conditions which infavourably influenced the fauna. On the basis of these it is natural, that the fauna is much poorer than that of the former subperiod. According to BACSÁK during this climate-type no inland ice-cover existed. Indeed, the fauna is much richer than at the time of the glacial subarctic oscillation of the upper humid period and at the time of the glacial subarctic oscillation of the upper arid period. This fact proves the correctness of BACSÁK's idea. Finally it must be mentioned, that inside the upper humid period the extent of the single subperiods and the duration of the corresponding climate-type of the climate curve show the same sequence.

After all on the basis of the analysis of the fauna of the upper humid period and on the basis of the subperiods of this fauna the astronomical climate-curve of MILANKOVICH and BACSÁK may be followed with success. With the aid of the fauna it succeeded the exact delimitation of the theoretical climate-types in the sediments too. The theoretical mounts of the climate-curve were filled up with concrete contents by the analysis of the fauna.

(To be continued.)

II. or the upper humid period of the boring of Felsőszentiván

Astronomical chronologie		Würm$_1$ — Würm$_2$ interstadial													
		Subarctic			Antiglacial			Subtropical						Anti-glacial	
Stratigraphical chronologie		Riss — Würm interglacial													
Mollusca subperiods		II/1			II/2			II/3						II/4	
Stratigraphical profil		Humus containing loess						Running sand							
Species	Depth. m.	11,0—11,2	11,2—11,4	11,4—11,6	11,6—11,8	11,8—12,0	12,0—12,2	12,2—12,4	12,4—12,6	12,6—12,8	12,8—13,1	13,1—13,4	13,4—13,7	13,7—14,0	14,0—14,3	14,3—14,5
Viviparus viviparus L.										1			1			
Valvata cristata O. F. Müll.		2				1	20	12	87	239	58	18	61	21	3	4
Valvata pulchella Stud.		1	4	17	1		14	25	147	462	109	32	92	20	2	2
Valvata piscinalis O. F. Müll.										4			3			
Bithynia tentaculata L.								1								
Bithynia leachi Shepp.							1	3	17	48	8	3	8	4		
Stagnicola palustris O. F. Müll.									7	19	9	3	5			3
Galba truncatula O. F. Müll.		3	2	2	5	15	41	56	350	1 085	264	64	242	55	7	8
Physa fontinalis L.							2					1				
Aplexa hypnorum L.							3	2	15	52	12	1	10	2		
Planorbis corneus L. iuv.							3	2	11	4		7	1	6		1
Anisus planorbis L.		1	1	1	2	6	18	30	83	292	87	25	77	12	2	4
Anisus carinatus O. F. Müll.								1	4					1		
Anisus vortex L.							1									
Anisus septemgyratus E. A. Bielz						2	6	1		5	2	2	2	1		
Anisus leucostoma Millet			6	9	45	88	174	101	511	49	11	7	31	7		
Anisus spirorbis L.		4	11	5	5	23	92	78	658	3 442	905	187	956	257	35	42
Bathyomphalus contortus L.									1		2					
Gyraulus albus O. F. Müll.										1						
Gyraulus laevis Alder					2	3	9	4	29	35	7	4	14	2	1	1
Gyraulus crista L.									1							
Gyraulus crista var. *nautileus* L.									3	11	3		3	1		
Segmentina nitida O. F. Müll.							1		3	5			1			
Pisidium cinereum Alder		1			8	3	27	8	101	238	114	33	54	13	3	6
Pisidium personatum Malm									2	9			3			
Pisidium obtusale C. Pfeiffer					2	1		6	5	14			3			2
Pisidium pulchellum Jenyns									1							
Pisidium mitidum Jenyns									1							
Aquatic species altogether		12	24	34	70	142	412	330	2 037	6 015	1 591	387	1 567	402	53	73
Carychium minimum O. F. Müll.		6	15	6	37	78	321	164	530	2 031	429	174	744	243	24	35
Succinea oblonga Drap.		160	76	45	397	721	1 060	625	2 816	7 409	2 110	532	1 278	302	43	90
Amphibiotic species altogether		166	91	51	434	799	1 381	789	3 346	9 440	2 539	706	2 022	545	67	125
Cochlicopa lubrica O. F. Müll.		32	14	20	77	49	86	52	156	345	113	57	64	20	4	12
Vertigo pygmaea Drap.		86	74	54	266	298	344	204	1 169	2 285	512	178	1 190	372	43	36
Vertigo antivertigo Drap.							7	10	136	196	23	15	63	13	4	2
Vertigo angustior Jeffreys			7	3	46	36	45	25	138	203	42	19	120	32	3	8
Pupilla muscorum L.		155	100	51	207	373	442	103	359	262	41	31	119	49	4	5
Vallonia pulchella O. F. Müll.		51	40		297	275	771	182	732	1 604	228	151	202	223	43	26
Vallonia enniensis Gredler		17	20	17	220	209	140	188	1 109	2 968	821	138	1 066	152	29	27
Vallonia costata O. F. Müll.		62	39	75	118	103	63	23	95	73	68	9	20	11	3	
Punctum pygmaeum Drap.		1	2	6	13	16	10	5	15	13	4	2	3	1		1
Vitrea crystallina O. F. Müll.		12	5		13	2	10	2	6	3	1		2			
Euconulus trochiformis Mont.					3	1	6	12	152	348	118	41	105	18	3	2
Deroceras agreste L.		15	9	8	31	38	33	24	145	357	94	20	33	5	2	6
Trichia hispida L.		67	30	21	56	69	117	57	260	110	51	13	32	12	6	2
Hygrophil ubiquist species altogether		498	340	255	1 347	1 469	2 074	887	4 472	8 767	2 116	674	3 019	908	144	127
Pupilla sterri Voith		3							9	12	8		35			
Clausilia dubia Drap.					1											
Goniodiscus ruderatus Studer		2			4	1	5	1	3	8	2	1	1			
Perpolita hammonis Ström		28	20	7	32	32	47	16	106	197	45	7	47	6	1	2
Fruticicola fruticum O. F. Müll.		3	8	2	4	3	3	7	4	4			10			
Perforatella bidens Chemn.		1			21	4	24	4	15	18	7	3	9			
Arianta arbustorum L.		2			9	3	3	13	18	34	35	8	2	9	2	2
Inhabitant of the groves altogether		39	28	9	71	43	82	41	155	273	97	19	104	15	3	4
Abida frumentum Drap.		22	21	18	26	100	3		10	12	1		1	2		
Imparietula tridens O. F. Müll.		44	30	41	15	33	14	14	25	51	21	9	9	9	2	3
Helicella hungarica Soós et h. Wagner		2			4	3		1	5	1		3	1			
Thermophilic species altogether		68	51	59	45	136	17	15	40	64	22	12	11	11	2	3
Vallonia tenuilabris Al. Braun									3							
Mollusca exemplars altogether		783	534	408	1 967	2 589	3 966	2 062	10 053	24 559	6 365	1 798	6 723	1881	269	332